

### **REMARKS**

Applicants thank the Examiner for acknowledging that the preliminary claim amendments have been entered. In addition, Applicants thank the Examiner for acknowledging Applicants' established priority date of February 8, 2001. Finally, Applicants thank the Examiner for noting that the IDS submitted February 4, 2002 was considered.

Applicants respectfully request reconsideration of the present application in view of the foregoing amendments and in view of the reasons that follow.

Claims 1-14 are currently being amended.

This amendment changes claims in this application. A detailed listing of all claims that are, or were, in the application, irrespective of whether the claim(s) remain under examination in the application, is presented, with an appropriate defined status identifier.

After amending the claims as set forth above, claims 1-14 are now pending in this application.

#### **Amendments to the Abstract**

The Abstract was objected to for various informalities. Amendments to the Abstract are presented as a new Abstract attached to this document to replace the previously submitted Abstract. Applicants respectfully submit that the Abstract is now in proper form and respectfully request that the objection be withdrawn.

#### **Amendments to the Specification**

The Specification was objected to for various informalities. Amendments to the specification are presented as a new specification attached to this document to replace the previously submitted specification. Applicants submit that no new matter has been added. Applicants respectfully submit that the Specification is now in proper form and respectfully request that the objection be withdrawn.

**Amendments to the Drawings**

In the Office Action, the drawings were objected to. In particular, figures 1-3D were objected to for not being labeled prior art. Figures 4A-6 were objected to for not being properly enumerated and Fig. 7 was objected to for typographical errors.

Applicants respectfully submit that Figures 1-3D are not prior art in that they illustrate elements of the claimed invention. In compliance with 37 CFR § 1.81, Figures 1-3D are provided for the understanding of the subject matter patented. Therefore, Applicants respectfully request withdrawal of the objection and that the drawing Figures 1-3D be accepted as originally submitted.

The specific changes that have been made to Figures 4B-6 is that the Figures are now denoted with similar notations to that of Figure 4A. Specifically, the virtual vertex has been labeled “Si,” the edge has been labeled “Ai” and the vertex to be removed is labeled “Sr.”

The specific changes that have been made to Figure 7 is that typographical errors in the drawing have been corrected and notations have been added to clearly define what is being shown in the drawing. Specifically, step 42 now reads “Object fully returned to resting position?” The path between step 42 and step 40 is labeled “yes.” The path between step 42 and step 44 is labeled “no.” These changes are supported by at least pages 18 and 19 of the specification.

Thus, Applicants respectfully submit that the drawings are now in proper form and respectfully request that the objection be withdrawn.

**Claim Objections**

Claims 1-14 were objected to for various informalities. In response, without agreeing or acquiescing to the objections, Applicants amend claims 1-14 as suggested by the Examiner to eliminate the informalities cited by the Examiner. Applicants submit that claims 1-14 are now in proper form and are allowable. Thus, Applicants respectfully request that the objections be withdrawn.

**Claim Rejections under 35 U.S.C. § 112**

In the Office Action, Claims 1-14 were rejected under 35 U.S.C. § 112, second paragraph. In response, without agreeing or acquiescing to the rejection, Applicants amend claims 1-14 as suggested by the Examiner. Applicants submit that claims 1-14 now particularly point out and distinctly claim the subject matter of the claimed invention. Thus, Applicants respectfully request that the rejection be withdrawn.

**Claim Rejection under 35 U.S.C. § 101**

Claims 1-14 were rejected under 35 U.S.C. § 101 for being directed to both an apparatus and a method. In response, without agreeing or acquiescing to the rejection, Applicants amend claims 1-14 to further clarify the claimed invention. Applicants respectfully submit that claims 1-14 are directed toward an apparatus for simulating the deformation of materials.

For example, as recited in claim 1, the apparatus comprises a memory and a computer, wherein the computer has a first module configured to “determine repeatedly, for each mesh, the deviation between the current length ( $l_j$ ) of an edge of the mesh and its previous length and/or its length at rest ( $L_j$ ), and to store respective force data ( $F_j^n$ ) relating to a potential energy of deformation for each vertex of the mesh, the respective force data being obtained from said deviation” and a second module configured to “determine repeatedly, for each vertex, new data as to the position of this vertex ( $S_j(Q_n)$ ) as a function of the composition of the forces exerted thereon ( $F_j^n$ ), data relating to at least one previous position of the vertex ( $S_j(T_n)$ ) and mechanical parameters of the material.”

One embodiment of the resulting structure of the claimed invention is shown, for example, in Figure 1. Thus, Applicants respectfully submit that claims 1-14 are properly directed to an apparatus and request that the rejection be withdrawn.

**Claim Rejection under 35 U.S.C. § 102**

In the Office Action, Claims 1-5 and 8-14 were rejected under 35 U.S.C. § 102 as being anticipated by French Patent Publication FR 2,771,202 (“Cotin et al.”).

In response, without agreeing or acquiescing to the rejection, Applicants amend claims 1 and 6 to further define the invention. Applicants respectfully submit that claims 1-14 are allowable for at least the following reasons.

Applicants respectfully traverse the rejection of claim 1 as amended. Applicants rely on M.P.E.P. § 2131, entitled “Anticipation – Application of 35 U.S.C. § 102(a), (b) and (e)” which states, “a claim is anticipated only if each and every element set forth in the claim is found, either expressly or inherently described, in a single prior art reference.” Applicants respectfully submit that Cotin et al. does not teach each and every element of claim 1 as amended.

First, The Patent Office has not identified with any particularity any of the claimed limitations of claims 1-14 that are allegedly disclosed in Cotin et al. Instead, there is only a general reference to several figures and passages of Cotin et al. The Patent Office’s failure to identify any of claimed limitations with specificity is not surprising because Cotin et al. fails to disclose, teach or suggest all the claimed limitations of claim 1. If the rejection of claims 1-14 is to be maintained, Applicants respectfully request a non-final Office Action addressing each of the claim limitations.

Moreover, the claims contain the recitation of features that are not present in Cotin et al. In particular, claim 1 as amended is directed to an apparatus for simulating the deformation of materials, comprising a computer having a module configured to “determine repeatedly, for each mesh, the deviation between the current length and/or its length at rest ( $L_j$ ), and to store respective force data ( $F_j^n$ ) relating to a potential energy of deformation for each vertex of the mesh, the respective force data being obtained from said deviation...” Thus, the module claimed in amended claim 1 obtains the force data from a deviation of the length of an edge of the mesh (*See* Formula 12).

In contrast, Cotin et al. teaches that the internal forces applied to each node of a volume mesh are obtained from a provided vector displacement to each mesh node. Specifically, Cotin et al. discloses that "the nodes belonging to the surface mesh cell, the locus of the collision with the tool, are subjected to the vector displacement provided

(distributed according to the barycentric coordinates of the said nodes), then the internal forces applied at each node of the volume mesh are estimated..." (See page 23, line 31 – page 24, line 4.) In addition, Cotin et al. teaches the use of "matrices and tensors...calculated on the basis of a volume linear elastic deformation law." (See page 44, line 21.) Thus, Cotin et al. is based on a linear model and uses an entirely different mathematical approach than the claimed invention. This approach prevents Cotin et al. from accurately predicting the reaction to a force exerted on various types of deformable material, specifically in the case of large movements.

As stated above, the computer of the claimed invention is configured to determine the deviation between the current length of an edge of a mesh and the resting length of an edge of the mesh in order to estimate a derivative of the potential energy of the deformation of each mesh. This estimate is expressed as a function of a Green-St Venant tensor and mechanical coefficients inherent in the material of the mesh. The force or composition of forces exerted at the subject vertex is obtained by expressing the derivative of the potential energy in relation to the position of the vertex. The claimed invention can thus be used to simulate large movements and/or non-linear elasticity of objects formed of various materials.

In light of the above, Applicants submit that claim 1, as currently amended, is not anticipated by Cotin et al. and respectfully request that the rejection be withdrawn. Applicants also respectfully request that the Examiner withdraw the rejections to claims 2-5 and 8-14, which depend on claim 1 and are allowable for at least the reasons set forth above.

#### **Claim Rejections under 35 U.S.C. § 103**

Claims 6 and 7 were rejected under 35 U.S.C. § 103 as being unpatentable over Cotin et al. in view of either Picinbono, Lombardo, Delingette and Ayache, "Anisotropic Elasticity and Force Extrapolation to Improve Realism of Surgery Simulation," 2000 ("Picinbono") or Delingette, Cotin and Ayache, "A Hybrid Elastic Model allowing Real-Time Cutting, Deformation and Force-Feedback for Surgery Training and Simulation," 2000 ("Delingette").

In response, without agreeing or acquiescing to the rejection, Applicants amend claims 1 and 6 to further define the invention. Claims 6 and 7 are dependent upon claim 1 as

amended. As stated above, Cotin et al. does not teach, suggest or disclose all the features of independent claim 1. Further, Picinbono and Delingette fail to cure the deficiencies of Cotin et al. Thus, Applicants respectfully submit that claims 6 and 7 are allowable and respectfully request that the rejection be withdrawn.

**Conclusion**

Applicant believes that the present application is now in condition for allowance. Favorable reconsideration of the application as amended is respectfully requested.

The Examiner is invited to contact the undersigned by telephone if it is felt that a telephone interview would advance the prosecution of the present application.

The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16-1.17, or credit any overpayment, to Deposit Account No. 19-0741. Should no proper payment be enclosed herewith, as by a check being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 19-0741. If any extensions of time are needed for timely acceptance of papers submitted herewith, Applicant hereby petitions for such extension under 37 C.F.R. §1.136 and authorizes payment of any such extensions fees to Deposit Account No. 19-0741.

Respectfully submitted,

Date November 7, 2005

FOLEY & LARDNER LLP  
Customer Number: 22428  
Telephone: (202) 672-5416  
Facsimile: (202) 672-5399

By Brian J. McNamara Reg. No. 32,789  
/s/ Brian J. McNamara  
Attorney for Applicant  
Registration No. 32,789



### ABSTRACT

The invention relates to the simulation of the deformation of materials, notably of soft body tissues. An apparatus comprises a memory (MEM, NT) storing data as to the position of an object, recorded at the vertices of a grid pattern, and data for force to be exerted on the object. A computer ( $\mu$ P, MT) evaluates new positions of the vertices, as a function of a force exerted globally and mechanical parameters of the material. According to the invention, this computer comprises a module for calculating, for each mesh, a deviation between the current length of an edge and its previous length, and the force data at each vertex of the mesh. Another module calculates, for each vertex, new positional data relating to this vertex as a function of the forces exerted thereon and its previous position.

**Deleted:** Apparatus for simulating the deformation of materials, notably of soft body tissues

**Deleted:** (Figure 1)

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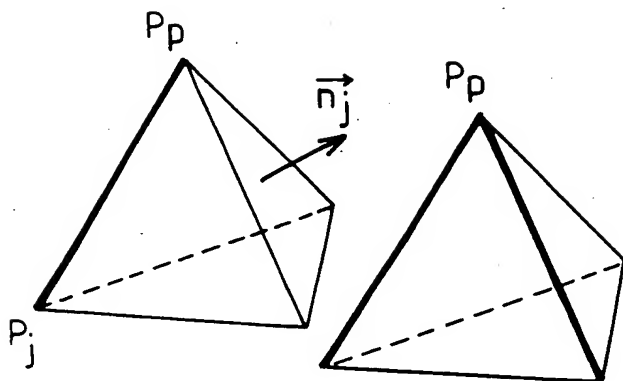


FIG. 3A

FIG. 3B

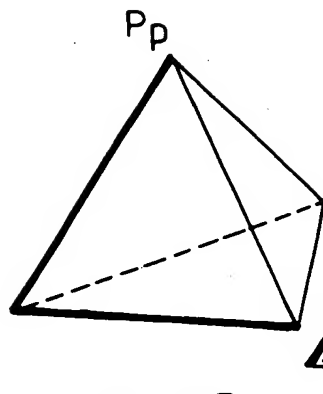


FIG. 3C

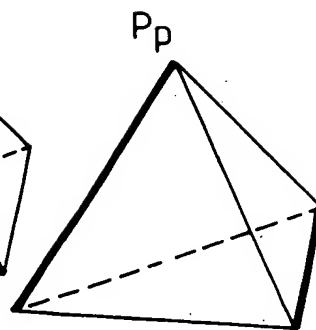


FIG. 3D

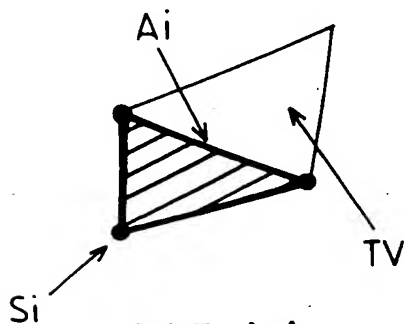


FIG. 4A

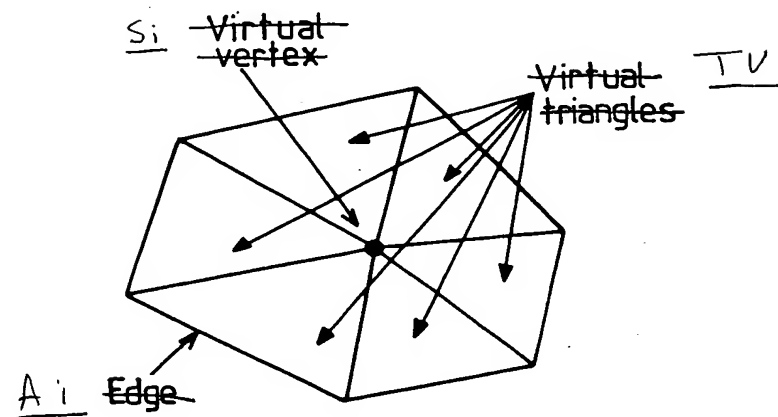


FIG. 4B

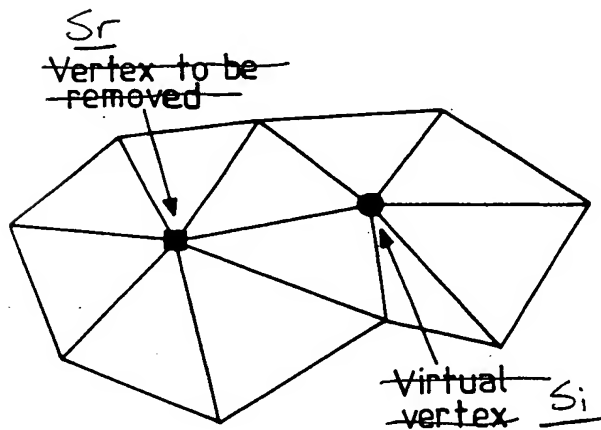


FIG. 5A

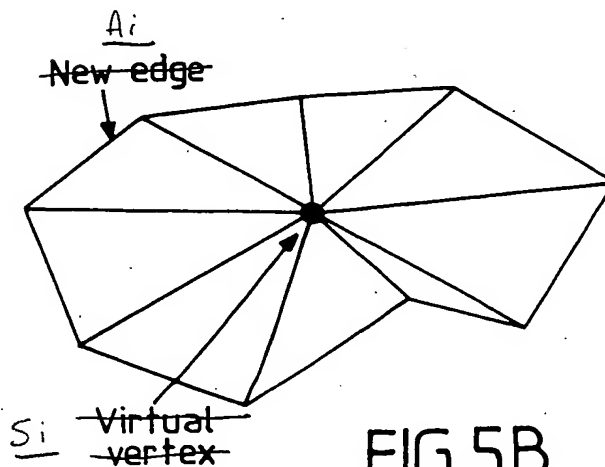


FIG. 5B

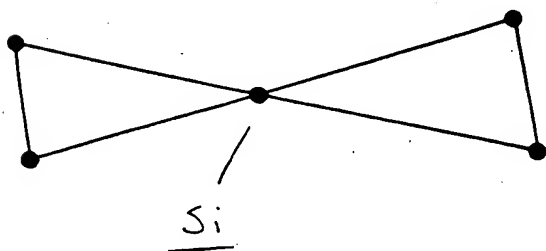


FIG. 6



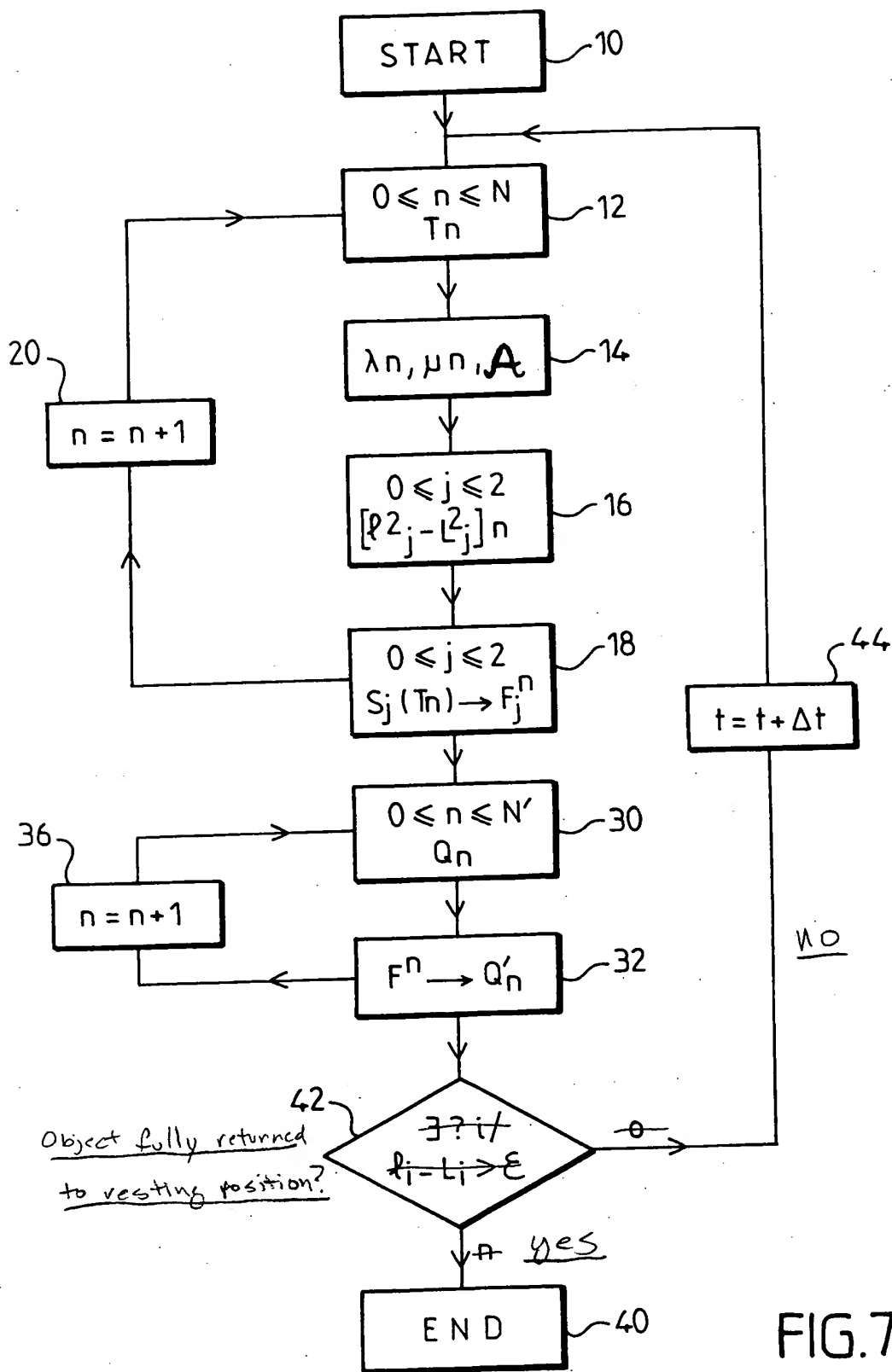


FIG.7